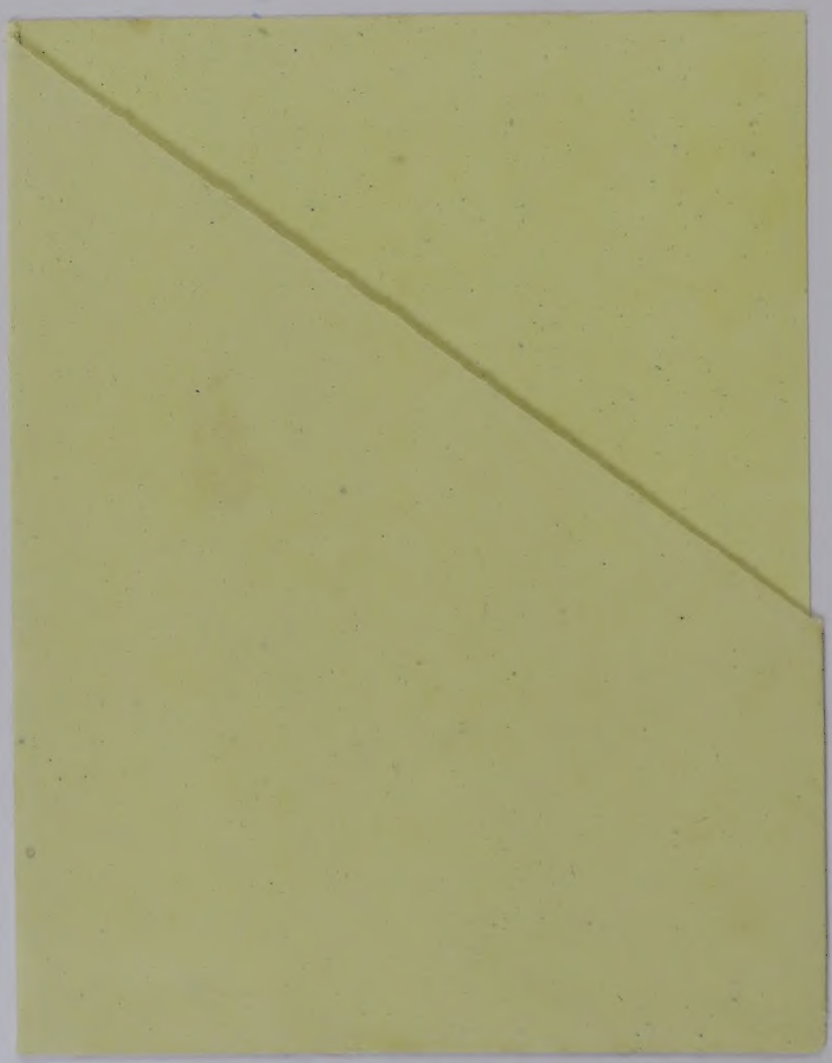
Special Report Series No. 44

MANUAL OF STANDARDS OF QUALITY FOR DRINKING WATER SUPPLIES

(Second Edition)

INDIAN COUNCIL OF MEDICAL RESEARCH
NEW DELHI
1975



COMMUNITY HEALTH CELL

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MANUAL OF STANDARDS OF QUALITY FOR DRINKING WATER SUPPLIES

(Second Edition)

COMMUNITY HEALTH CELL
326, V Main, I Block
Koramangala
Bangalore-560034
India

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ERRATA

Page No.		For	Read
Page 10	Para 2.3	Clostridium Welchii	Clostridium perfringens
Page 27	Ref. 16	McKae, J.E. and Wold., H.W.	McKee, J.E. a Wolf, H.W.

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FOREWORD

Water meant for human consumption should not only be free from micro-organisms and excessive concentrations of chemical and radioactive substances, but should also be palatable. Absence of turbidity, colour, smell and disagreeable taste are also important in public supply of drinking water.

The Indian Council of Medical Research had published a *Manual of Standards of Quality for Drinking Water Supplies* in 1962. The ever-increasing knowledge of the nature and effect of various contaminants, and the availability of techniques for identifying and determining their concentrations, have led to a need for further revision of the manual.

This Manual contains revised chemical and bacteriological standards of quality for drinking water. The virological standards could not be recommended due to lack of standard techniques for viral enumeration in water. Although it is theoretically possible that viral diseases can be transmitted by water free from coliform organisms, yet conclusive evidence that this actually does occur is lacking. The resistance of coliform organisms and of viruses to disinfection by oxidants increases with increasing concentrations of reducing components e.g., organic matter. It cannot be assumed that the absence of viable coliform organisms always implies freedom from active viruses particularly under circumstances where a free chlorine residual cannot be maintained. Sedimentation and slow filtration may contribute to the removal of viruses from water; hence the importance of such a treatment.

It is hoped that this revised Manual will serve the purpose of standardisation of quality for safe water supply in order to maintain public health and reduce morbidity from various water-borne diseases. The Manual may also be of help in devising new and improved treatment processes which will ensure maintenance of a uniform high standard of water supply to the community.

C. GOPALAN
DIRECTOR-GENERAL
Indian Council of Medical Research

New Delhi, the
16th December, 1975

1. INTRODUCTION

Manual of Standards of Quality for Drinking Water Supplies[1] was first published by the Indian Council of Medical Research (ICMR) in 1962 in connection with the Environmental Sanitation Research Programme in the Second Five-Year Plan of the Government of India. These recommendations were accepted with minor modifications in the *Manual on Water Supply*[2] published by the Union Ministry of Health and have been adopted, in whole or part, by a number of States and other authorities.

Increasing knowledge of the nature and effect of various contaminants and non-availability of water resources in certain parts of the country that conform to the standards prescribed in the 1962 edition, have led to a demand for revision of the recommendations. Accordingly, the ICMR convened a Working Group in New Delhi in March, 1975. This edition is the outcome of the Committee's deliberations.

In the preparation of the material for this publication use was made of many sources, including the earlier edition of the ICMR *Manual of Standards of Quality for Drinking Water Supplies*[1], *US Public Health Service Drinking Water Standards*[3], *Canadian Drinking Water Standards and Objectives*[4], Reports on the *Bacteriological Examination of Water Supplies London (No.71)*[5], *WHO European Standards for Drinking Water*[6], *WHO International Drinking Water Standards*[7], *Ministry of Works and Housing, Government of India, Manual of Water Supply and Treatment, 2nd Edition*[8] and the *Standard Method for the Examination of Water and Waste Water*[9].

Due regard has been given to the prevailing conditions in India relating to the provision of drinking water supplies, the progress of the schemes under the various national and State development programmes, and the need for prescribing standards of bacteriological and chemical quality which would safeguard the health of the consumers and at the same time be liberal enough to permit the acceptance of supplies which would be satisfactory as regards their sanitary conditions. The Working Group further decided that the criteria of acceptability should vary somewhat between water supplies which are subjected to treatment including chlorination or other measures for disinfection and those which are untreated.

In the opinion of the Committee, the standards prescribed are technically and economically achievable with ordinary care and available treatment measures. They are recommended for immediate country-wide adoption.

In presenting these standards, the Working Group adopts the philosophy that water for drinking, culinary and other domestic uses should be free

from pathogenic organisms and their indicators, and from deleterious chemical substances and radioactive materials. It should also be palatable as far as local conditions permit, aesthetically appealing and devoid of objectionable colour, odour and taste.

In recommending these standards to the community at large, it is hoped that, by incorporating graded scales and providing detailed explanations, responsible authorities will be able to apply them with understanding, judgement and discretion. These standards are recommended on the basis of currently available information, and are subject to revision or adjustment as new and more significant data become available.

2. DRINKING WATER STANDARDS

2.1 QUALITY STANDARDS FOR DRINKING WATER:

The following quality standards for drinking water in India are recommended by the ICMR. These recommendations apply to all public, private, individual or small community water supplies. In their application, it is intended that, where doubts arise regarding interpretation, the consumer shall be guided by the appropriate health or public health engineering authority.

Water intended for human consumption should be free from micro-organisms likely to cause diseases and chemical constituents which may impair health. The water should be aesthetically attractive for the ordinary consumer who judges its quality by physical appearance and taste.

2.2 DISEASES TRANSMITTED THROUGH WATER SUPPLIES:

The diseases which are known to be commonly transmitted through water supplies, such as cholera, typhoid and the dysenteries, are all intestinal infections in which the causative agent is excreted in the faeces of infected persons. The chief danger, associated with drinking water, is, therefore, the possibility of its recent contamination by sewage or human excrement.

2.3 METHODS FOR DETECTING FAECAL BACTERIA:

Methods for detecting the presence of the organisms causing these diseases in water are complicated, time consuming and difficult to accomplish with certainty. It is also not practicable to attempt to isolate the pathogenic organisms as a routine procedure, from samples of drinking water for assessment of its sanitary quality. Therefore, the bacteria of the coliform group of organisms,which are constantly present in great abundance in the intestinal tract of man and which are easy to detect when present in water, are employed as indicators of pollution. Their presence in a sample of water is looked upon as an indication of the probable presence of intestinal pathogens. If they are not found in water, it can be inferred that pathogenic organisms of water-borne diseases are also absent.

Other bacteriological indicators of excretal pollution such as faecal streptococci (*Streptococcus faecalis*) and anaerobic spore-forming organisms

(*Clostridium welchii*) have also been used in judging the sanitary quality of drinking water. The natural habitat of faecal streptococci is the intestine of mammalian species. They are usually present in faeces in smaller numbers than the coliform organisms and tend to die rapidly in water. Their occurrence in a sample of water affords confirmatory evidence of recent excretal contamination. *Clostridium welchii* also occur regularly in faeces in varying numbers. The spores of this organisms outlive the bacteria of the coliform group in water. Hence, the presence of these spores in water indicates that faecal contamination has occurred intermittently or a long time ago. Owing to their great abundance in the intestinal tract of man, and the ease with which they can be detected in water, the coliform organisms are the most delicate and sensitive bacteriological indicators of excretal contamination. The standards of bacteriological quality for drinking water, therefore, are based on the occurrence and number of coliform bacteria in the water expressed in terms of the most probable number (MPN) in 100 ml, as ascertained by the approved methods of examination. The coliform group includes all aerobic and facultative anaerobic, gram-negative, non-spore-forming, motile and non-motile rods capable of fermenting lactose at 35 to 37°C in less than 48 hours.

2.4 PHYSICAL AND CHEMICAL QUALITIES OF WATER:

The physical and chemical quality of water is important as the palatability of the water and its fitness for domestic purposes largely depend on its chemical quality. In view of the wide variations in the chemical quality of water available in different parts of the country, rigid limits cannot be laid down with regard to chemical constituents. Certain chemical substances, which may be present in natural waters are toxic to human beings. These should not be permitted in drinking water in excess of the permissible concentration. Certain other chemical substances render the water unpalatable and unfit for domestic use,if present in excessive amounts. For these substances, the 'highest desirable' and 'maximum permissible levels' have been prescribed. The limit designated as the 'highest desirable level' applies to a water that would generally be acceptable to consumers. Figures in excess of this level, while not acceptable, may be tolerated in the absence of a better alternate source to the limit designated as the 'maximum permissible level'. Above this level the water supply should normally be rejected.

The suitability of any water for drinking purposes with regard to its chemical quality has, therefore, to be determined on the basis of the general characteristics of the water available in the locality, and its freedom from toxic substances.

In applying bacteriological and chemical standards of quality for drinking water supplies, it is essential that the samples for the test are collected and analysed by competent and trained personnel, in strict accordance with the methods prescribed in the Manual of Methods for Examination of Water, Sewage and Industrial Wastes[10].

It should be stressed that the acceptance of any water supply should be based, not only on the results of the bacteriological and chemical examination, but due consideration should be given to the information

gathered from a sanitary survey of the sources of supply and the conditions of the distribution system. The interpretation of the results of bacteriological examination, in terms of the hygienic quality of water, demands careful consideration of all these factors and adequate experience on the part of the interpreter.

COMMUNITY HEALTH CELL
326, V Main, I Block
Koramangala
Bangalore-560034
India

3. SANITARY SURVEY

A sanitary survey of the source of water supply and its distribution is very important in interpreting the results of analytical examinations. This survey should include collection of accurate data on the nature and source of the supply, the possibilities of pollutants gaining access to the supply, method of treatment adopted, conditions of the distribution system and any other information which would be relevant from the sanitary point of view. The survey must be carried out by competent and trained persons. The results of laboratory examinations should be considered in conjunction with the sanitary survey data before a definite opinion on the safety of supply is pronounced.

4. SAMPLING

4.1 GENERAL CONSIDERATIONS:

Correct sampling is of utmost importance, for upon it depends the deductions which are ultimately drawn from the results of analysis. The sample should be representative of the water under examination and greatest care should be taken to avoid accidental contamination of the sample during collection. If the sample is intended to represent the water supply of a town, it should be taken from a pipe in direct communication with the street main, and not from a cistern or from a pipe supplied from a cistern. When samples for different examinations are taken from the same sampling point, the sample for bacteriological examination should be collected first. All samples should be labelled carefully, showing the source of the sample, the date and the time of collection and the name and designation of the person collecting the sample.

4.2 SAMPLES FOR BACTERIOLOGICAL EXAMINATION:

Samples for bacteriological examination should be collected in clean 500 ml sterilized bottles made of neutral glass, and provided with screw-caps or dust proof glass stoppers. If the water to be sampled contains or is likely to contain residual chlorine, a small quantity of Sodium thiosulphate (0.1 ml of 3.0 per cent solution or a small crystal) should be added to the bottle before sterilization. The bottle should be unstoppered just before collection of the sample.

4.3 COLLECTION FROM TAPS:

The tap should be opened fully and the water allowed to run for two minutes to wash out local impurities and remove the water standing in the service pipe, before collecting the sample. The tap should then be sterilized by heating with a blow lamp or by an ignited piece of cotton wool soaked in methylated spirit, until it is quite hot. It should be cooled by allowing the water to flow before the sample is taken. The bottle should be held near the base with one hand and the stopper and paper cover over it removed together. On no account should the stopper or the mouth of the bottle come in contact with the hand or any other object. The open mouth of the bottle is placed under the tap and the water allowed to flow in without splashing until the bottle is almost, but not quite, full and the stopper replaced. Leaking taps, where the water flows over the outside, should be avoided as far as possible.

4.4 COLLECTION FROM RIVERS, RESERVOIRS AND WELLS:

Samples from rivers and streams should not be taken too near the bank or too far away from the point of draw-off. For collecting samples directly from rivers, lakes, tanks, wells etc., a stoppered bottle with a string attached to the neck, wrapped in paper and sterilized, may be used. Before collecting the sample, the paper cover and the stopper should be removed and the bottle lowered into the water with the aid of the sterilized string, attaching a longer string if necessary. Care should be taken to see that the stopper and the mouth of the bottle do not come in contact with any object. After the bottle is full, it should be lifted out of the water and the stopper replaced immediately.

Another method for collecting a sample from a river or a reservoir is to hold the bottle at the base, remove the stopper and plunge the bottle neck downwards below the surface of the water. The bottle is then turned until the neck points slightly upwards, the mouth directed towards the current. If no current exists, one can be artificially created by pushing the bottle horizontally forward in a direction away from the hand. The bottle is removed when full and the stopper replaced immediately.

In taking a sample from a well, fitted with a pump, the water should be pumped to waste for about two minutes and the sample collected from the pump delivery or from a tap on the discharge.

The samples should be examined immediately after collection; if this cannot be done they must be packed in ice for transmission to the laboratory. Iced samples should be examined within 24 hours of collection.

4.5 SAMPLES FOR CHEMICAL EXAMINATION:

Samples for physical and chemical examination should be collected in clean glass stoppered bottles made of neutral glass with a minimum capacity of 2 litres; stoppered glass bottles technically known as 'Winchester Quarts' are suitable. Before collecting the sample, the bottle is well rinsed three times with the water, filling it each time about 1/3 full. Finally the bottle is filled, the stopper covered with a piece of cloth which is tied down tightly with string and sealed.

4.6 FREQUENCY OF SAMPLING:

The frequency with which samples of water are collected from a water supply, for the control of the sanitary quality of the supply, will depend on the nature of the source from which the water supply is taken, the treatment carried out and the size of the population served. The water, as it enters the distribution system, should be examined bacteriologically at least once a day. This may be done once a week, if the supply is chlorinated. In such cases, it is essential that the chlorination process should be checked often and the results recorded.

The minimum number of samples, which should be taken from the distribution system and examined each month, should be as follows:

Population served	Minimum number of samples to be taken from the entire distribution system during one month.
Up to 1,00,000	One sample per 5,000 of population with a minimum of 4 samples.
More than 1,00,000	One sample per 10,000 of population with a minimum of 20 samples

The frequency of sampling and the location of sampling points on the distribution system should be spread throughout the month and throughout the entire distribution system, so as to determine accurately the bacteriological quality of the supply during the period. The sampling points and the frequency with which samples from each point should be collected must be decided, after taking into consideration local conditions of the supply.

As a rule, collection of samples for chemical examination will not be as frequently required as for bacteriological examination. Collection of samples of water for examination for toxic substances should be carried out at least once every three months. If raw water is likely to get contaminated with toxic substances from industrial wastes, more frequent examinations are necessary. Samples for other chemical examinations should be collected at least once every three months in supplies serving a population of more than 50,000 and at least twice a year in supplies serving a population of less than 50,000. For new sources of supply, the samples should be collected more frequently and examined for toxic substances and for general chemical characteristics.

The bacteriological examination can be supplemented with the much simpler colorimetric test for free and combined residual chlorine. Disappearance of residual chlorine is an immediate indicator of the entry of oxidisable matter or of a malfunctioning of the treatment process. As chlorine residual tests can be carried out in a relatively short time by unskilled staff without laboratory facilities, it is recommended that maximum use should be made of such tests as a supplement to, though not as a substitute for, the bacteriological testing programme described later in this Manual.

5. STANDARDS OF BACTERIOLOGICAL QUALITY

5.1 TREATED WATER:

Efficient purification of a water supply which includes chlorination or some other form of disinfection should render the supply free from coliform bacteria in 100 ml of the sample tested. This quality should, therefore, be the aim for treated water for distribution.

The following standards of bacteriological quality are recommended for treated water (chlorinated or otherwise disinfected) distributed for human consumption.

Throughout any month, in 90 per cent of the samples examined coliform bacteria should be absent in 100 ml. No sample should contain *E coli* in 100 ml. No sample should contain more than 10 coliform organisms per 100 ml.

If any coliform organisms are found, the action required is immediate re-sampling. An MPN of coliform bacteria of 10 per 100 ml should not occur in consecutive samples. If two consecutive samples show an MPN of coliform bacteria in excess of 10 per 100 ml, additional samples should be collected from the same sampling point every day and tested until two consecutive samples show an MPN of less than 10 coliform bacteria per 100 ml. If necessary, samples for examination should also be taken from several other points in the distribution system and from the service reservoirs, pumping stations and treatment plant. In addition, the operation of all treatment processes should be checked for ascertaining the cause for the fall in the bacterial quality of the supply and suitable remedial measures taken. Some deterioration in bacterial quality is likely to occur in a water supply where the water has to traverse an extensive distribution system and in the case of intermittent supplies. When evidence of such deterioration persists, it calls for a special action.

5.2 INDIVIDUAL OR SMALL COMMUNITY SUPPLIES:

Ideally any public water supply should be chlorinated or disinfected as a matter of policy. This ideal cannot be universally attained at the present time in this country. In certain areas it may be economically impracticable to supply water to consumers through a piped distribution network and reliance has to be placed on individual wells, bores and springs. The same standard, however should be the aim and everything possible should be done to prevent access of pollutants to the water. By relatively simple

measures, such as the removal of obvious sources of contamination from the catchment area and by attention to the coping, lining and covering, it should be possible to reduce the coliform count of water from even a shallow well to less than 10 per 100 ml. Persistent failure to achieve this, particularly if *E. coli* is repeatedly found in two consecutive samples, should, as a general rule, lead to the condemnation of the water supply.

6. VIROLOGICAL EXAMINATION

6.1 VIRUSES IN WATER:

It is theoretically possible that virus diseases can be transmitted by water free from coliform organisms, but conclusive evidence that this has occurred is lacking.

The problems associated with viruses in waters are becoming of increasing importance. Over 75 viruses are now known to be pathogenic to man. Viruses found in polluted water include the adenoviruses, coxsackie viruses, ECHO viruses, viruses of infectious hepatitis, polio-viruses and reoviruses. Among the diseases caused by these viruses, only infectious hepatitis is known sometimes, to be water-borne[11,12,13,14]. There is, however, some evidence that poliovirus and adenovirus infections can be transmitted by polluted water.

6.2 REMOVAL OF VIRUSES FROM WATER:

Viruses can be removed to a great extent during water treatment, if the latter is carried out efficiently. In a water, in which free chlorine is present, active viruses will be generally absent, if coliform organisms are absent. For this reason and because coagulation, sedimentation and filtration,in themselves,may contribute to the removal of viruses from water, the importance of such treatments must be stressed. In practice, 0.5 mg/l of free chlorine for one hour is sufficient to inactivate virus, even in water that was originally polluted.

Virological techniques have not yet been developed to the stage when virus enumerations can be recommended as a routine procedure in microbiological examinations of drinking water. Development of methodology to permit such routine examination is currently under investigation. At the present state of our knowledge,it is not possible to specify a quantitative limit on viruses, frequency of viral assay and routine methods of viral detection, identification and quantification.

7. STANDARDS OF PHYSICAL AND CHEMICAL QUALITY

7.1 TOXIC SUBSTANCES:

The following concentrations of chemicals should be regarded as tentative limits. Concentration of a chemical higher than the maximum specified limit given below should not be permitted in treated water as it may constitute a definite danger to health.

Substances	Upper limit of concentration
Arsenic	0.05 mg As/l
Cadmium	0.01 mg Cd/l
Lead	0.1 mg Pb/l
Mercury	0.001 mg Hg/l
Selenium	0.01 mg/Se/l
Cyanide	0.05 mg Cn/l

The limits given above should be considered in conjunction with the explanatory notes that follow. Drinking water supplies in which any of the mentioned toxic substances are present in excess of the upper limit of concentration must be rejected as unfit for human consumption.

7.1.1 Arsenic:

Arsenic in water may be carcinogenic. There have been several instances where cancers have been attributed to arsenic,but no real proof of carcinogenicity to man due to arsenic in drinking water has been forthcoming. The toxicity of arsenic is well-known, and ingestion of as little as 100 mg usually results in severe poisoning. A single dose may require 10 days for complete disappearance, and its cumulative toxic effects are attributable to this slow excretion. In the light of our present knowledge concerning the potential health hazard from ingestion of inorganic arsenic, it would seem wise to keep the level of arsenic in drinking water as low as possible.

7.1.2 Cadmium

Consumption of cadmium salts causes cramps, nausea, vomiting and diarrhoea. Cadmium tends to concentrate in the liver, kidneys, pancreas and thyroid of human beings. The sources of cadmium contamination in water are seepage of cadmium into ground waters from electroplating plants and

from zinc galvanized iron in which cadmium is a contaminant. Animal experiments have shown that minute amounts of cadmium can give rise to nephrotoxic and cardiovascular changes. Concentrations of cadmium in excess of 0.01 mg/l in drinking water are grounds for rejection of the supply.

7.1.3 Cyanide:

In the consideration of limits for cyanide in drinking water, it may be noted that the acceptable daily intake for man of hydrogen cyanide residues in some fumigated food has been established at 0.05 mg per kg of body weight per day. For the protection of the health of human beings, concentrations above 0.2 mg/CN/l constitute grounds for rejection of the supply. Cyanide is readily destroyed by conventional treatment and the level of 0.05 mg CN/l is such as to ensure that the source of water is not too highly contaminated by industrial effluents.

7.1.4 Lead:

The maximum acceptable load of lead for food and beverages has been tentatively placed at 0.05 mg per kg body-weight per day. Lead taken into the body can be seriously injurious to health, even lethal, if taken during short or prolonged exposure. Prolonged exposure to relatively small quantities may result in serious illness or death. Lead taken into the body in quantities in excess of a certain relatively low normal limits is a cumulative poison. Poisoning may result from an accumulation in the body if lead is absorbed in sufficient quantities from any one or all the three common sources: food, air, and water, including the water used in cooking and in beverages. Lead compounds are used as stabilisers in some plastic pipes and may leak into the water. Concentrations of lead in excess of 0.1 mg/l are grounds for rejection of the supply because of the seriousness of the cumulative toxic effects of lead.

7.1.5 Mercury:

Mercury and mercuric salts are considered to be highly toxic to man. Toxicological data indicate that mercury is a cumulative poison. There is no information available on the acceptable daily intake for man and the limit recommended is related to the levels found in natural waters in other countries.

7.1.6 Selenium:

Although selenium is found in some natural waters, food appears to be the more likely source of human ingestion. Definite symptoms of selenium poisoning have not been identified, though it is commonly believed that selenium is highly toxic to man. It has been stated that symptoms of selenium poisoning are similar to those of arsenic poisoning. Arsenic and selenium are apparently antagonistic in their toxicity tending to counteract each other. The upper limit of concentration is fixed because of the

similarity between arsenic and selenium poisoning, its dental effect and its known toxicity to live-stock.

7.2 SUBSTANCES AND CHARACTERISTICS AFFECTING POTABILITY OF WATER:

Certain chemical substances present in water and certain characteristics of the water, although not constituting a hazard to the health of the people using it, may affect its acceptability as a domestic supply. A list of such substances and characteristics is given in Table I, together with an indication of the undesirable effects they may produce and figures of the 'highest desirable' and 'maximum permissible levels' recommended. The limits described as 'highest desirable' apply to water which will be generally acceptable to the consumers. Concentrations exceeding the limit given as the 'maximum permissible level' will be unsatisfactory for drinking and domestic purposes.

These limiting concentrations are mainly indicative, and where alternative supplies conforming to these standards are not available, these may have to be further relaxed individually, provided they are not harmful to health.

7.3 RADIOACTIVE SUBSTANCES*:

With increasing use of radioactive materials for research, medicine, agriculture and other activities and the establishment of atomic reactors, the problem of contamination of water with radioactive materials constitutes an increasing health hazard. As far as possible, efforts should be made to prevent radioactive wastes from gaining access to sources of water used for drinking and domestic water supplies. As this may not be possible in some instance, limiting concentrations of radioactivity are suggested for water to be used for drinking and domestic purposes. These limits are based on the recommendations of the International Commission on Radiological Protection.

It must be pointed out that these figures are recommended as the upper safe limits of concentration. If the levels exceed these limits, radiochemical analysis should be carried out for determining the nature of the radio nuclides present before deciding on the safety of the water for human consumption. These figures also refer to drinking water for lifetime use. They include naturally occurring radioactivity as well as radioactivity which may reach the water through effluents from nuclear reactors or other sources.

Maximum permissible limit of radioactivity

Gross alpha activity	3 pCi/l
Gross beta activity	30 pCi/l

If these limits are not exceeded, no radiochemical analysis is required.

*To be referred to Atomic Energy Commission for expert advice.

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Annex 1

TABLE 1

Substances and Characteristics Affecting the Acceptability of Water for Domestic Use

Substances or characteristics	Undesirable effect that may be produced	Highest desirable level	Maximum permissible level
1	2	3	4
Substances effecting the colour, TCU (1)	Discolouration	5 units	25 units
Substances causing odours	Odours	Unobjectionable	Unobjectionable
Substances altering the taste	Taste	Unobjectionable	Unobjectionable
Turbidity, JTU (2)	Gastrointestinal irritation	5 units	25 units
Dissolved solids	Gastrointestinal irritation	500 mg/l	1500 mg/l*
pH range	Taste, corrosion, scale formation	7.0 to 8.5	6.5 to 9.2
Total hardness	Taste, scale formation	300 mg $CaCO_3$/l	600 mg $CaCO_3$/l
Calcium	Taste, scale formation	75 mg Ca/l	200 mg Ca/l
Magnesium	Taste, scale formation, gastrointestinal irritation in presence of sulphates.	Not more than 50 mg/l Mg, if there are 200 mg/l sulphates; if there is less sulphate, magnesium up to 100 mg/l Mg may be allowed at the rate of 1 mg/l Mg for every 4 mg/l *decrease* in sulphates.	100 mg Mg/l
Copper	Astringent taste, discolouration, corrosion of pipes, fittings, utensils	0.05 mg Cu/l	1.5 mg Cu/l

1	2	3	4
Iron	Astringent taste, discolouration, turbidity, deposits, growth of iron bacteria in pipes.	0.1 mg Fe/l	1.0 mg Fe/l
Manganese	Astringent taste, discolouration, turbidity, deposits in pipes.	0.1 mg Mn/l	0.5 mg Mn/l
Chloride	Taste, corrosion in hot water systems	200 mg Cl/l	1000 Mg Cl/l
Sulphates	Gastrointestinal irritation when combined with magnesium or sodium	200 mg SO_4/l	400 mg SO_4/l
Nitrate	Danger of infantile methaemoglobinaemia, if the water is consumed by infants.	20 mg NO_3/l	**
Fluoride	Fluorosis***	1.0 mg F/l	1.5 mg F/l
Phenolic compounds	Taste, particularly chlorinated water	0.001 mg phenol/l	0.002 mg phenol/l

The values prescribed are to be considered individually and may not bear correlation with each other.

1. True colour unit, platinum-cobalt scale.

2. Jackson Turbidity Unit.

* Dissolved solids relaxable up to 3000 mg/l in cases where alternate sources are not available within reach.

** More information is required to prescribe a value but in no circumstances should the level exceed 100 mg NO_3/l.

Excessive nitrates in drinking water may cause methaemoglobinaemia in some young infants[15] No simple or economical method for removing nitrates from water is available. Hence, it is recommended that in the case of water supplies containing nitrate in excess of the limiting concentrations, the consumers should be advised as to the potential danger of using the water for infant feeding.

*** The presence of fluoride in drinking water in excess of 1.0 mg/l gives rise to dental fluorosis (mettling) of varying degrees of severity in children. When present in high concentrations, fluorides may eventually cause endemic cumulative fluorosis with resultant skeletal damage in children and adults.

Annex 2

MEMBERSHIP OF THE ICMR EXPERT COMMITTEE TO REVISE THE MANUAL ON STANDARDS OF QUALITY FOR DRINKING WATER SUPPLIES

Dr. T.R. Bhaskaran,
Technical Director,
Geo Miller and Co. Pvt. Ltd.,
D-2, N.D.S.E.-II,
New Delhi-47. *Chairman*

Shri B.K. Baweja,
Director (Hqrs)
Central Ground Water Board,
Faridabad N.H.4

Dr. M.I. Gurbaxani,
Superintendent,
Water and Sewage Works,
Tata Iron and Steel Company Ltd.,
Jamshedpur.

Dr. V.B. Khilnani,
Superintending Hydrogeologist,
Groundwater Department,
C-103, Shastri Nagar,
Jodhpur-342001.

Dr. N. Majumdar,
Director,
National Environmental Engineering
Research Institute,
Nehru Marg, Nagpur.

Shri S.K. Mathur,
Deputy Director,
Indian Standards Institution,
New Delhi-110002.

Shri M. Maikhan,
Secretary,
Central Water Pollution Board,
Ministry of Works and Housing,
Nirman Bhavan, New Delhi.

Dr. L.N. Mohapatra,
Professor of Microbiology,
All India Institute of
Medical Sciences,
New Delhi.

Shri K.C.B. Raju,
Hydrogeologist,
Central Ground Water Board,
Geological Survey of India,
Jamnagar House,
New Delhi.

Shri B.B. Rau,
Deputy Adviser (PHE),
Central Public Health
and Environmental Engineering
Organization,
Ministry of Works & Housing,
Nirman Bhavan,
New Delhi.

Brig. L.D. Sachdeva,
Officer Commanding,
Command Pathology Laboratory,
Delhi Cantt-10.

Dr. (Mrs.)S.M. Vachha,
Assistant Director of
Health Services &
I/C State Public Health
Laboratory,
Poona.

Shri K.E. Bulusu,
Senior Scientist,
National Environmental Engineering
Research Institute,
Nehru Marg,
Nagpur. *Secretary*

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Printed at the ICMR Offset Press, New Delhi

COMMUNITY HEALTH CELL
326, V Main, I Block
Koramangala
Bangalore-560034
India